MULTIMEDIA UNIVERSITY®

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2015/2016**

## PME0016 – MECHANICS

(Foundation in Engineering - All Sections / Groups)

29 FEBRUARY 2016
9.00 A.M – 11.00 A.M
(2 Hours)

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**INSTRUCTIONS TO STUDENTS**

1. This question paper consists of **FIVE** printed pages, excluding the cover page, Appendix I and Appendix II, with **FIVE** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

## ANSWER ALL QUESTIONS

### QUESTION 1 (10 Marks)

a) State two conditions of equilibrium for a rigid object.

(2 marks)

b) A uniform metal block with a mass of 100.0 kg is placed on a uniform and horizontal beam as shown in Figure Q1. The beam is supported by two vertical supports at positions 7.5 m from either end of the beam (Q and R). The beam has a weight of 750.0 N and a length of 30.0 m.

i) Sketch all forces acting on the beam.

(2 marks)

ii) Calculate the force exerted by each of the vertical supports on the beam.

(4 marks)

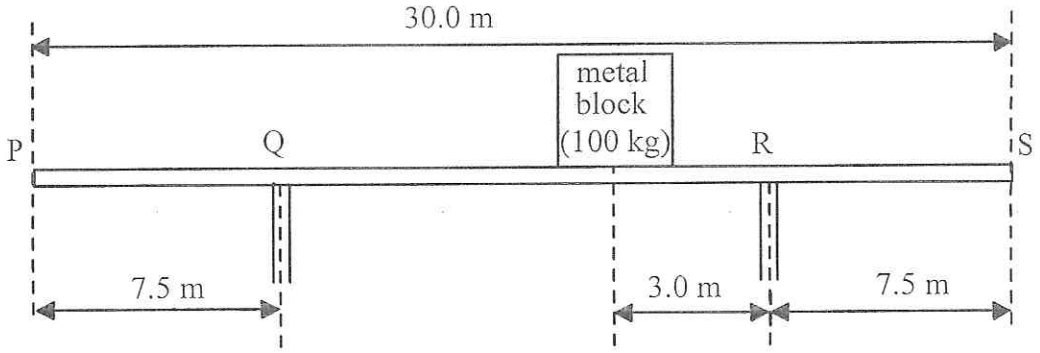


**Figure Q1**

c) i) Define the meaning of center of gravity of an object.
ii) Where is the center of gravity for a uniform object?

(2 marks)

Continued...

## QUESTION 2 (10 Marks)

a) State the principle of conservation of energy.

(2 Marks)

b) What do you understand by the work-energy theorem?

(2 Marks)

c) A 0.4 kg bead slides on a curved wire, starting from rest at point A as shown in **Figure Q2**. If the wire is frictionless, find the speed of the bead at B and at C.

(6 Marks)

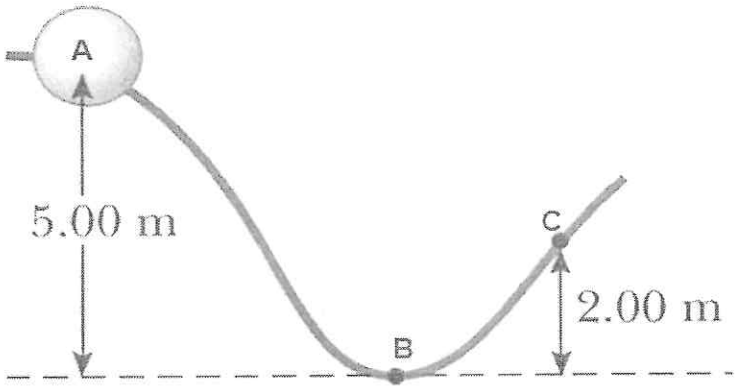


**Figure Q2**

## QUESTION 3 (10 Marks)

a) The tubes in **Figure Q 3(a)** are rotating at 10000 rpm, with the bottom of the tubes 10.0 cm from the axis of rotation.

i) Determine how many rotations each tube makes in one second.
ii) Determine the angular frequency of the tubes.
iii) Find the linear speed of the bottom of the tubes.
iv) What is the centripetal acceleration at the bottom of the tubes ?

(8 Marks)

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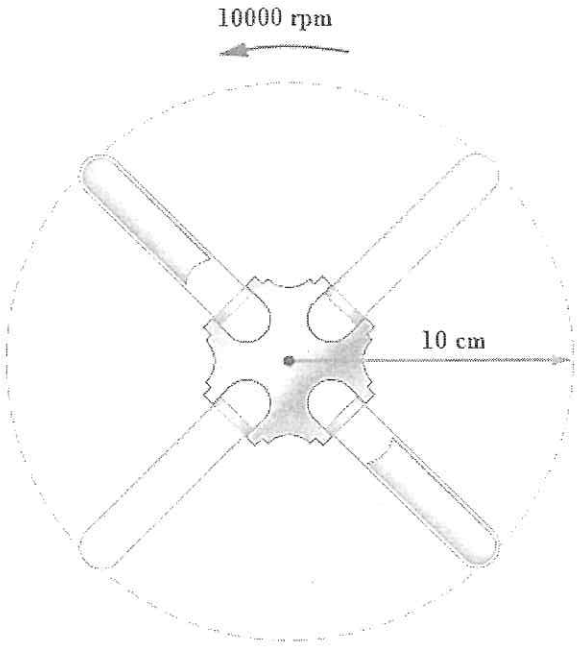


**Figure Q 3(a)**

b) Referring to **Figure Q 3(b)**, show that the sum of the kinetic energy of $n$ particles of the rigid body is equal to the rotational kinetic energy of the body.

(2 Marks)

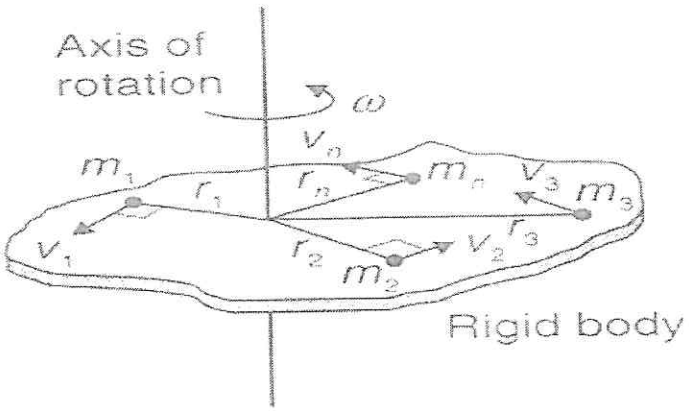


**Figure Q 3(b)**

**Continued...**

## QUESTION 4 (10 Marks)

a) An experiment was done in a lab to determine the value of Young's modulus of a wire of diameter 4.0 mm. **Figure Q 4(a)** shows the original set up before the experiment began. **Figure Q 4(b)** shows an object of mass 50 kg was suspended at the end of the wire which caused the wire to extend. Calculate the values of the stress, the strain, and the Young's modulus of the wire.

(5 marks)

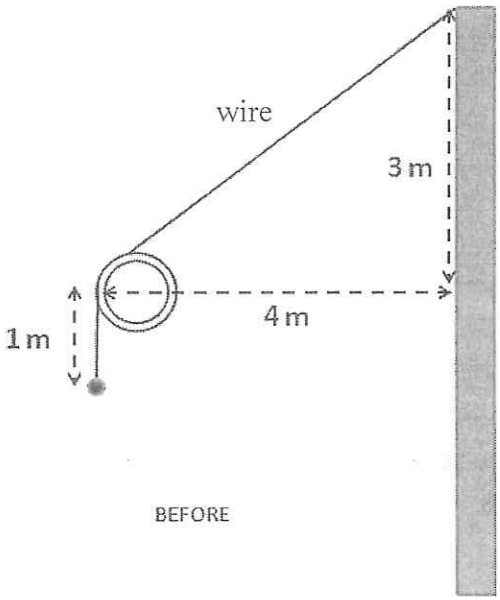


**Figure Q 4(a)**

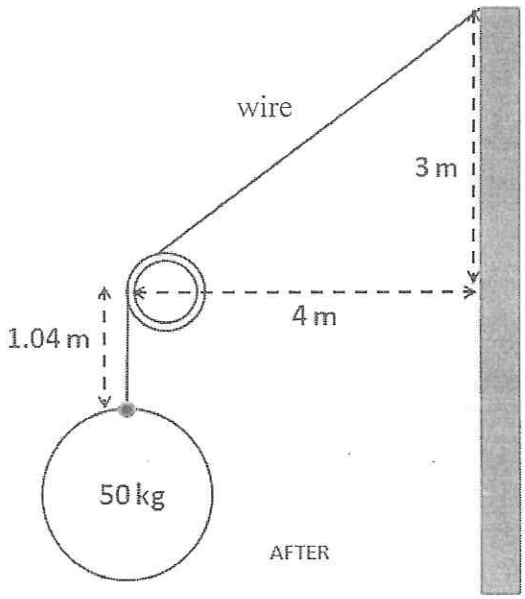


**Figure Q 4(b)**

b) **Figure Q 4(c)** shows graph of force against elongation of a typical steel wire. State briefly the points or region labelled with A, B, C, D, and E. (5 marks)

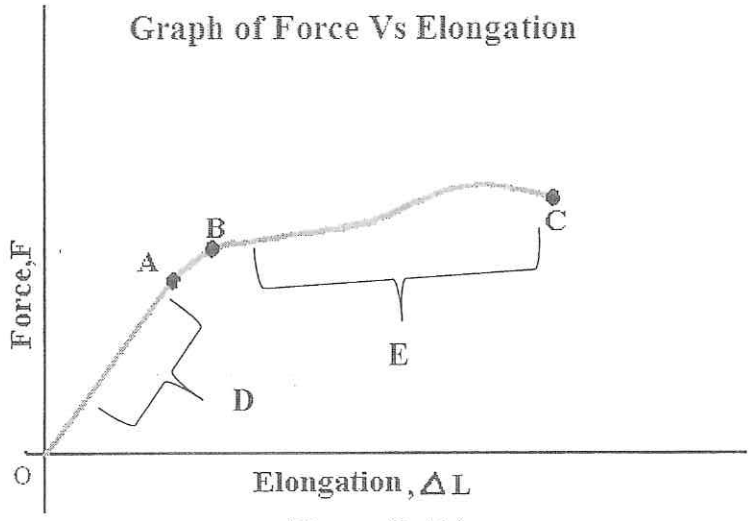


**Figure Q 4(c)**

**Continued...**

## QUESTION 5 (10 Marks)

a) What is the difference between a periodic motion and a simple harmonic motion?
(2 marks)

b) Determine the amplitude, the period, the frequency and the angular frequency of the motion shown in **Figure Q 5**.

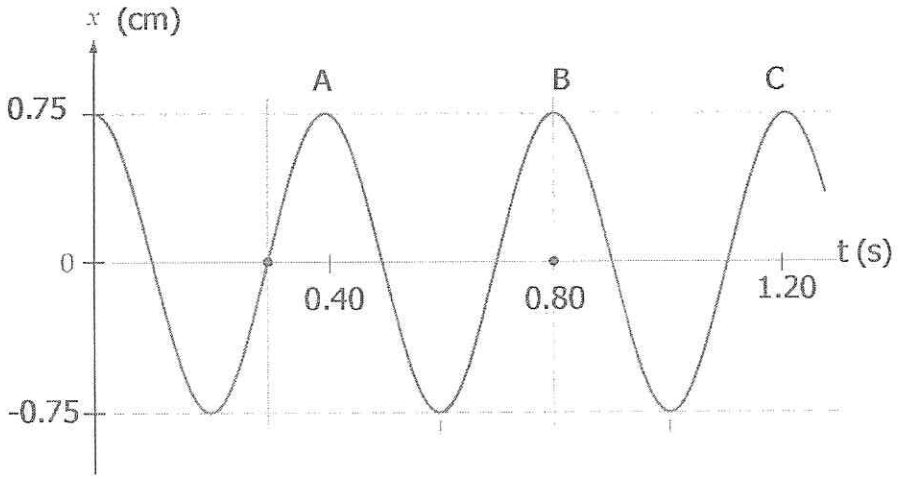


**Figure Q 5**

(4 marks)

c) A 50 g mass vibrates in simple harmonic motion at the end of a spring. The amplitude of the motion is 12 cm and the period is 1.70 s. Find
i) the frequency of the system,
ii) the spring constant,
iii) the maximum speed of the mass, and
iv) the maximum acceleration of the mass.

(4 marks)

**End of Paper**

**APPENDIX I:**

## LIST OF PHYSICAL CONSTANTS

| | | | |
|---|---|---|---|
| Electron mass, | $m_e$ | = | $9.11 \times 10^{-31}$ kg |
| Proton mass, | $m_p$ | = | $1.67 \times 10^{-27}$ kg |
| Neutron mass, | $m_n$ | = | $1.67 \times 10^{-27}$ kg |
| Magnitude of the electron charge, | $e$ | = | $1.602 \times 10^{-19}$ C |
| Universal gravitational constant, | $G$ | = | $6.67 \times 10^{-11}$ N.m$^2$ / kg$^2$ |
| Universal gas constant, | $R$ | = | 8.314 J/ mol.K |
| Hydrogen ground state, | $E_0$ | = | 13.6 eV |
| Boltzmann's constant, | $k_B$ | = | $1.38 \times 10^{-23}$ J/K |
| Compton wavelength, | $\lambda_c$ | = | $2.426 \times 10^{-12}$ m |
| Planck's constant, | $h$ | = | $6.63 \times 10^{-34}$ J.s |
| | | = | $4.14 \times 10^{-15}$ eV.s |
| Speed of light in vacuum, | $c$ | = | $3.0 \times 10^8$ m/s |
| Rydberg constant, | $R_H$ | = | $1.097 \times 10^7$ m$^{-1}$ |
| Acceleration due to gravity of earth, | $g$ | = | 9.80 m/s$^2$ |
| 1unified atomic mass unit, | 1 u | = | 931.5 MeV/c$^2$ |
| | | = | $1.66 \times 10^{-27}$ kg |
| 1 electron volt, | 1 eV | = | $1.60 \times 10^{-19}$ J |
| Avogadro's number, | $N_A$ | = | $6.023 \times 10^{23}$ mol$^{-1}$ |
| Threshold of intensity of hearing, | $I_0$ | = | $1.0 \times 10^{-12}$ W/m$^2$ |
| Coulomb constant, $k = \frac{1}{4\pi\varepsilon_0}$ | | = | $9.0 \times 10^9$ N.m$^2$ /C$^2$ |
| Permittivity of free space, | $\varepsilon_0$ | = | $8.85 \times 10^{-12}$ C$^2$/N.m$^{-2}$ |
| Permeability of free space, | $\mu_0$ | = | $4\pi \times 10^{-7}$ T.m/A |
| 1 atmosphere pressure, | 1 atm | = | $1.0 \times 10^5$ N/m$^2$ |
| | | | $1.0 \times 10^5$ Pa |
| Earth: Mass, | $M_E$ | = | $5.97 \times 10^{24}$ kg |
| Radius (mean), | $R_E$ | = | $6.38 \times 10^3$ km |
| Moon: Mass, | $M_M$ | = | $7.35 \times 10^{22}$ kg |
| Radius (mean), | $R_M$ | = | $1.74 \times 10^3$ km |
| Sun: Mass, | $M_S$ | = | $1.99 \times 10^{30}$ kg |
| Radius (mean), | $R_S$ | = | $6.96 \times 10^5$ km |
| Earth-Sun distance (mean), | | = | $149.6 \times 10^6$ km |
| Earth-Moon distance (mean), | | = | $384 \times 10^3$ km |

**APPENDIX II:**

## LIST OF FORMULAS IN MECHANICS

| | | | |
|---|---|---|---|
| $y = kx^n$<br>$\frac{dy}{dx} = knx^{n-1}$ | $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ | $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ | $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$ |

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2}gt^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$

$y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum\tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2}I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2}at^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$

$x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $\quad m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $\quad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$